

NOTES ON SOME JURASSIC SHELLS FROM BORNEO, INCLUDING  
A NEW SPECIES OF *TRIGONIA*.

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PLATE XVI.

THE Jurassic rocks of Borneo appear to be restricted to the western part of the island, and chiefly to that area known as the Sultanate of Sambas; they occur also in certain parts of the country of the Sarawak river, and in some west central localities lying among the upper reaches of the river Kapuas. Only the first two districts have yielded molluscan remains, the third forming the area wherein Dr. G. A. F. Molengraaff discovered siliceous organic rocks containing Radiolaria, which were described some few years since by Dr. G. J. Hinde<sup>1</sup> as of probably Jurassic age (= Danau formation or pre-Cretaceous of Molengraaff).<sup>2</sup>

Mr. C. J. van Schelle, a mining engineer, first collected Jurassic shells in the Sepang and Mottong districts of Western Borneo, although Professor K. Martin, in describing their characters during 1890, mistook them for specimens of probably Cretaceous age; they comprised two forms of *Gervillia* and a *Corbula*. Subsequently, with more information at his command, Martin was able to regard these fossils as of Lias age, on account of their association with Ammonites resembling *Harpoceras radians*.

Professor Martin next called attention to Jurassic mollusca obtained by Mr. Wing Easton and Dr. Bosscha from various localities of Sambas, including the genera *Corbula*, *Protocardia*, *Exelissa*, etc., as well as some Ammonite remains identified as *Perisphinctes*. He was in favour of regarding this fauna as of Jurassic age, since the Cephalopod was more particularly represented in the 'Malm' of Europe and in the Indian Jurassic Series.

This same group of shells was afterwards described by Dr. F. Vogel as belonging to the 'Brauner' or 'Weisser Jura' period, although he was inclined to think that the later age was the more correct one.

During the same collecting expedition molluscan remains were found which proved to be of older date than those just referred to, on account of the presence of Ammonites allied to *Harpoceras radians*, a characteristic Cephalopod of the Upper Lias formation, these specimens being described and figured at the time by Dr. P. G. Krause.

<sup>1</sup> G. J. Hinde: "Description of Fossil Radiolaria from the Rocks of Central Borneo, obtained by Professor G. A. F. Molengraaff in the Dutch Exploring Expedition of 1893-1894"; Leyden, 1899.

<sup>2</sup> G. A. F. Molengraaff: "Borneo-Expeditie: Geologische Verkenningstochten in Central-Borneo (1893-1894)"; Leyden and Amsterdam, 1900. Ibid., English translation, published 1902.

The occurrence of Jurassic rocks in the Sarawak river district was made known by the present writer in 1897 through the examination of material in the British Museum (Natural History) containing *Alectryonia amor*, an ostreiform shell of Middle Oolite age.

## BIBLIOGRAPHY.

The literature on the Jurassic conchology of Borneo includes the following papers:—

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## LIST OF THE KNOWN JURASSIC SHELLS FROM BORNEO.

	LIAS.	OOHITE.
CEPHALOPODA.		
<i>Aptychus</i> sp. ... ..	*	
<i>Haploceras</i> sp. (group <i>H. radians</i> , Reinecke) ... ..	*	
<i>Perisphinctes</i> sp. ... ..		*
GASTROPODA.		
<i>Acteonina</i> (?) <i>Martini</i> , Vogel ... ..		*
<i>Alaria</i> cf. <i>trifida</i> , Phillips ... ..		*
<i>Cerithium contortum</i> , Vogel ... ..		*
<i>Cerithium</i> sp. ... ..		*
<i>Euspira borneensis</i> , Vogel ... ..		*
<i>Exelissa septemcostata</i> , Vogel ... ..		*
<i>Ficula</i> sp. ... ..		*
<i>Lunatia Sambasana</i> , Vogel ... ..		*
<i>Pseudomelania</i> cf. <i>abbreviata</i> , Roemer ... ..		*
<i>Strombus</i> sp. ... ..		*
LAMELLIBRANCHIA.		
<i>Alectryonia amor</i> , D'Orbigny ... ..		*
<i>Area</i> sp. ... ..		*
<i>Astarte borneensis</i> , Vogel ... ..		*
<i>Astarte Eastoni</i> , Vogel ... ..		*
<i>Astarte</i> sp. ... ..		*
<i>Corbula</i> <i>Vogeli</i> , Cossmann (= <i>borneensis</i> , Vogel, preoccupied)		*

	LIAS.	OOLITE.
<i>Corbula Eastoni</i> , Vogel ... ..		*
<i>Corbula</i> sp. indet. ... ..	*	
<i>Cucullæa</i> sp. ... ..		*
<i>Cuspidaria</i> [ <i>Neæra</i> ] <i>Sambasana</i> , Vogel ... ..		*
<i>Gervillia Borneensis</i> , Martiu ... ..	*	
<i>Gervillia</i> sp. indet. ... ..	*	
<i>Inoceramus</i> sp. ... ..	*	
<i>Mytilus Sambasanus</i> , Vogel ... ..		*
<i>Pholadomya</i> cf. <i>multicostata</i> , Agassiz ... ..		*
<i>Protocardia crassicostata</i> , Vogel ... ..		*
<i>Protocardia multiformis</i> , Vogel ... ..		*
<i>Protocardia tennicostata</i> , Vogel ... ..		*
<i>Pseudomonotis</i> sp. ... ..		*
<i>Pteroperna</i> sp. ... ..		*
<i>Trigonia Molengraaffi</i> (sp. nov.) ... ..		*
<i>Volsella</i> [= <i>Modiola</i> ] sp. ... ..		*

Attention may now be directed to a small collection of Jurassic shells obtained by Mr. Edward T. McCarthy from Buduk (= Boedok) in the Dutch territory of Western Borneo, which he presented to the British Museum (Natural History) during 1897. The specimens vary in mineralization, having been found in some altered clay-beds of the old Chinese gold-mines, and comprise Gastropod and Lamelli-branch remains associated with coniferous wood and impressions of erinoidal stem fragments. From their occurrence in a soft ferruginous red-clay deposit the tests of the majority of the shells are converted into a kind of brown iron-ore or limonite; these particular specimens being collected at about 50 feet below the original surface. Some further material consists of numerous casts of small bivalves, *Trigonia*, etc., crowded together and forming nodular or spherical masses of a grey-coloured cindery-looking rock.

Molluscan remains (*Euspira* and *Protocardia*) are also observable in a greyish-black, compact, siliceo-calcareous matrix (weathering almost white), heavily charged with iron pyrites, and exhibiting a small percentage of gold, which came from a depth of 89 feet. At a similar depth from the surface a hard reddish clay rock was obtained, showing indeterminable shell fragments (*Euspira*), which, among other minerals, according to Mr. McCarthy, also contains gold to the amount of 2 dwts. per ton. This little collection, besides being illustrative of species described by Dr. Vogel in 1896 and 1900, includes the genus *Trigonia*, which is now recorded for the first time from the Jurassic rocks of Borneo.

#### 1. TRIGONIA MOLENGRAAFFI, n.sp. (Pl. XVI, Figs. 1-6.)

Shell small, ovately trigonal, moderately convex, and of nearly equal height and length; anterior border rounded, posterior end truncated; umbones almost mesial, obtuse, slightly recurved; area depressed, covered with closely-set transverse striations divided by a feeble though distinct median furrow; marginal carina gently curving and slightly raised, the inner carina shorter; escutcheon narrow and of small dimensions; surface ornamented with concentrically excavated, step-like costæ, equally spaced, and elevated; intercostal areas furnished with numerous perpendicular clavate ridges bearing oblique striations.

*Dimensions*.—Largest example, 20 by 20 mm.; smallest example, 15 by 15 mm.

This ornamental shell belongs to Agassiz's group *Clavellatæ*. Its delicate and regular sculpture suggests affinities with *T. formosa*, J. de C. Sowerby, *T. Phillipsi*, Morris & Lycett, and *T. Moutieriensis*,<sup>1</sup> Lycett, species which occur in the Lower Oolitic rocks of England and the Continent. In the general character of its costal system it comes perhaps closest to *T. Phillipsi*, although in that form the shell is more convex, more tubercled in its ornamentation, and the costæ descend more abruptly (almost perpendicularly) from the marginal carina, which is nearly straight or not so excavated as in the Borneo shell. In figure it is very similar to *T. Moutieriensis* from the French Oolites, but that again exhibits differences, having fewer costæ, wider inter-costal sulcations, and a coarser sculpture.

Further differences also separate the Borneo shell from *T. formosa*, which has a much wider area and smooth sulcations between the costæ, instead of the club-shaped structures peculiar to the present species. The oblique striations on the clavate ridges within the costæ do not appear to have been noticed before in connection with the shell-structure of *Trigonia*, although minute lineations can be seen on an allied Lower Oolite form known as *T. striata* of James Sowerby, occurring between the costæ and on the obtuse tubercles which ornament their summits. It is one of the few species of *Clavellate Trigonia*s which show a regular and symmetrical ornamentation. More often the sculpture of this group exhibits large tubercles irregularly placed over the surface; such forms are generally typical of Middle and Upper Oolite horizons, whilst the more regularly ornamented species appear to characterise deposits of Lower Oolitic age.

Both the ferruginous rock and the 'cindery' material contain this species. Two specimens occur in the former, showing internal and external characters; the crenulations on the diverging teeth, however, being very obscurely seen. They are furnished with about 15 rows of costæ, but mineralization has somewhat spoilt their original natural characters, so that the finer structures are not very apparent. The actual sculpture is best depicted in the specimens found in the grey-cindery rock, that occur only as hollow casts; but by means of wax impressions all the external details of structure have been reproduced with excellent results.

One of these specimens exhibits a well-marked, beautifully striated tooth, lying beneath the escutcheon area; it forms part of the example represented in pl. xv, fig. 2. A rough cast of a *Trigonia* of larger size than the foregoing occurs in the pyritized siliceous rock, but it is not sufficiently well preserved to allow of identification.

## 2. *PROTOCARDIA CRASSICOSTATA*, F. Vogel.

*Protocardia crassicostata*, Vogel: Samml. geol. R.-Mus. Leiden, vol. v (1896), p. 140, pl. ix, figs. 1-5.

<sup>1</sup> Further information respecting these species will be found in John Lycett's "Monograph of the British Fossil *Trigonia*" (Pal. Soc. Monogr.), 1872.

This species is largely represented in these beds, and is the most abundant shell in the present collection. It occurs both in the ferruginous red-clay formation and in the siliceo-pyritized rock.

### 3. *PROTocardia tenuicostata*, F. Vogel.

*Protocardia tenuicostata*, Vogel: Samml. geol. R.-Mus. Leiden, vol. v (1896), p. 142, pl. ix, figs. 6, 7; vol. vi (1900), p. 58, pl. ii, figs. 4-6.

The collection contains only a fragmentary example of this species, although quite sufficient for purposes of determination. It displays the typical sculpture with the closely-set vertical striations between the fine and numerous concentric costæ. It occurs in the ferruginous red-clay deposits.

### 4. *ARCA* sp.

*Arca* sp., Vogel: Samml. geol. R.-Mus. Leiden, vol. vi (1900), p. 50, pl. iii, fig. 16.

An impression of a portion of a valve of this shell, from which a wax squeeze has been made, gives the shape and concentric striations as described and figured by Vogel. It is found in the grey-coloured cindery rock.

### 5. *CORBULA* *VOGELI*, Cossmann.

*Corbula Borneensis*, Vogel: Samml. geol. R.-Mus. Leiden, vol. v (1896), pp. 144-146, pl. x, figs. 1-3; *non* Boettger, 1875, *nec* Krause, 1897. *Corbula Vogelii*, Cossmann: Revue Critique Paléozoologie, 1900, p. 12.

The grey-cindery rock contains impressions of a shell exhibiting the close and regular concentric sculpture characteristic of this species.

### 6. *PSEUDOMONOTIS* sp. (Pl. XVI, Fig. 7.)

A fragment of this genus occurs in the grey-cindery rock, accompanied by other shell remains and articular impressions of crinoidal stems. It represents a portion of the lower valve (about 10 mm. in length), with 8 or 10 diverging, longitudinal, rounded ribs, some of which appear to bifurcate about midway. These ribs are furnished at frequent and regular intervals with short open spines or fistulosities. The intercostal spaces are crowded with minute transverse striations. The only shell this fragment appears to resemble is the *Pseudomonotis echinata* of J. Sowerby, of Lias and Lower Oolite age. It was thought to be worthy of reference on account of the beautiful sculpture it exhibits.

### 7. *EUSPIRA BORNEENSIS* (F. Vogel).

*Amauropsis Borneensis*, F. Vogel: Samml. geol. R.-Mus. Leiden, vol. v (1896), p. 149, pl. x, figs. 7, 8; vol. vi (1900), p. 67, pl. iv, fig. 5.

*Euspira Borneensis*, Cossmann: Revue Critique Paléozoologie, 1900, p. 13.

This species, of which there are several examples in the collection, occurs in the red-clay beds. It possesses a prominent tabulate spire, with traces of sub-vertical striations of growth. M. Cossmann regarded



this form as a true *Euspira* on account of the elevated character of the whorls.

8. *ALARIA* cf. *TRIFIDA* (Phillips).

*Rostellaria trifida*, J. Phillips: Illustrations of the Geology of Yorkshire, 1829, p. 138, pl. v, fig. 14.

*Alaria* cf. *trifida*, Vogel: Samml. geol. R.-Mus. Leiden, vol. vi (1900), p. 71, pl. iv, figs. 7-9.

Two badly preserved Gastropods found in the red-clay beds appear to be referable to this form as recognized by Dr. Vogel.

9. *LUNATIA* *SAMBASANA* (F. Vogel).

*Amauropsis* (?) *Sambasana*, F. Vogel: Samml. geol. R.-Mus. Leiden, vol. v (1896), p. 149, pl. x, figs. 9, 10.

*Lunatia Sambasana*, Vogel: op. cit., vol. vi (1900), p. 67, pl. iv, fig. 6.

There is only one example of this species, which is of large size, measuring 28 by 18 millimetres. It possesses a fractured labrum; but its somewhat narrow form, well-developed spire, long body-whorl, and apertural characters agree in all essentials with Vogel's figures. A still larger specimen, which most probably belongs to this species, is much worn and contorted. Both were obtained from the red-clay ferruginous deposits.

10. *PSEUDOMELANIA* cf. *ABBREVIATA*, F. A. Roemer.

*Pseudomelania abbreviata*, Roemer: Verstein. nord. Oolithengeb. Hannover, 1836, p. 159, pl. x, fig. 4.

*Pseudomelania* cf. *abbreviata*, Vogel: Samml. geol. R.-Mus. Leiden, vol. vi (1900), p. 68, pl. v, figs. 1-3.

Represented by two specimens, one of which is only a fragment of the spire. The more perfect example corresponds with Vogel's account and figure of this shell, although somewhat smaller in size. They occur in the ferruginous red-clay beds.

11. *EXELISSA* *SEPTEMCOSTATA*, F. Vogel.

*Exelissa septemcostata*, Vogel: Samml. geol. R.-Mus. Leiden, vol. v (1896), p. 146, pl. x, figs. 4-6; vol. vi (1900), p. 66, pl. v, fig. 7.

The collection contains two examples of this species which, although not showing basal characters, exhibit the thick and prominent longitudinal costæ. They were found associated with casts of *Protocardia crassicostata* in the pyritized siliceo-calcareous rock.

Previous observers are inclined to regard this fauna as of Upper Oolitic or 'Weisser Jura' age, although its general facies is suggestive of an older period. The *Perisphinctes* described by Martin from Bengkagang in Sambas is stated to possess obscure ribs, which may be single or bifurcating, with smaller ones intervening, i.e. a long and a short rib alternating. Such characters scarcely apply to the biplicated forms of this genus belonging to Portlandian times, which exhibit definite bifurcation without evidence of minor intermediate ribbing. The mere obscurity of the bifurcating costæ accompanied by intervening ribs, such as characterise a form like *P. Martinsi*, would

